



Air Force & NASA Hosted Payload Forum

# **Hosted Payload Interface Guidelines - Thermal**

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# Thermal Interface Assumptions

- **Key assumptions**

- Once paired, the Host Spacecraft and the Instrument Developer work out the implementation details between them and record them in Thermal Interface Control Document (TICD)
- The Host Spacecraft will maintain its side of the interface at temperatures between -40 C and 70 C from Integration through Disposal portions of its life cycle
- The Host Spacecraft is responsible for the thermal hardware used to close out the interface between the Spacecraft and the instrument such as closeout MLI blanket; Instrument is responsible for all other thermal hardware on it

- A key thermal interface driver is the demand the instrument and spacecraft make on each other; lesser the demand, easier is the interface which leads to lower costs and better matching
  - The examples of these demands are: the survival heater power, instrument temperature monitoring by spacecraft, flight rules on orientation restrictions, etc.
- The required instrument radiator size can vary by a factor of four for depending on the location of the instrument on the LEO spacecraft
- Certain payload operating temperature requirements (e.g., very low temperature or very stringent thermal stability) can impose severe constraints on spacecraft operation
- **Instrument on GEO host should be aware of the backloading on their radiator from the spacecraft's hot part such as solar panel and antenna**



# Change from CII Document of 2013

(Based on TEMPO hosting experience)



- During the matching up TEMPO instrument with a host GEO satellite it was found that the backloading from the spacecraft solar panel on the instrument radiator was excessive and the heritage radiator design was not able to meet the instrument requirement
- The backloading from the solar panels from GEO satellites were found to be over 44 W/sq. m while the TEMPO heritage radiator design was designed for a maximum backloading of 25 W/sq. m
- As a thermally isolated payload, TEMPO had to manage its own heat transfer needs without support from the Host Spacecraft
- It was not feasible to change the TEMPO instrument radiator design at the late phase of the project; this led to instrument heat rejection responsibility had to be moved to spacecraft side of the interface



# Backloading on the Radiator



Another type of radiative input is backloading from one part of the spacecraft to another or to a third surface (like the shuttle). Because any two surfaces that view each other will interchange energy in the Infrared range, the interchange depends on the effective radiation factor between the two surfaces and their temperature.

$$\text{Backloading}_{1-2} = A \ SF \ \sigma (T_1^4 - T_2^4)$$

Where:

$A$  - area

$SF$  - script F

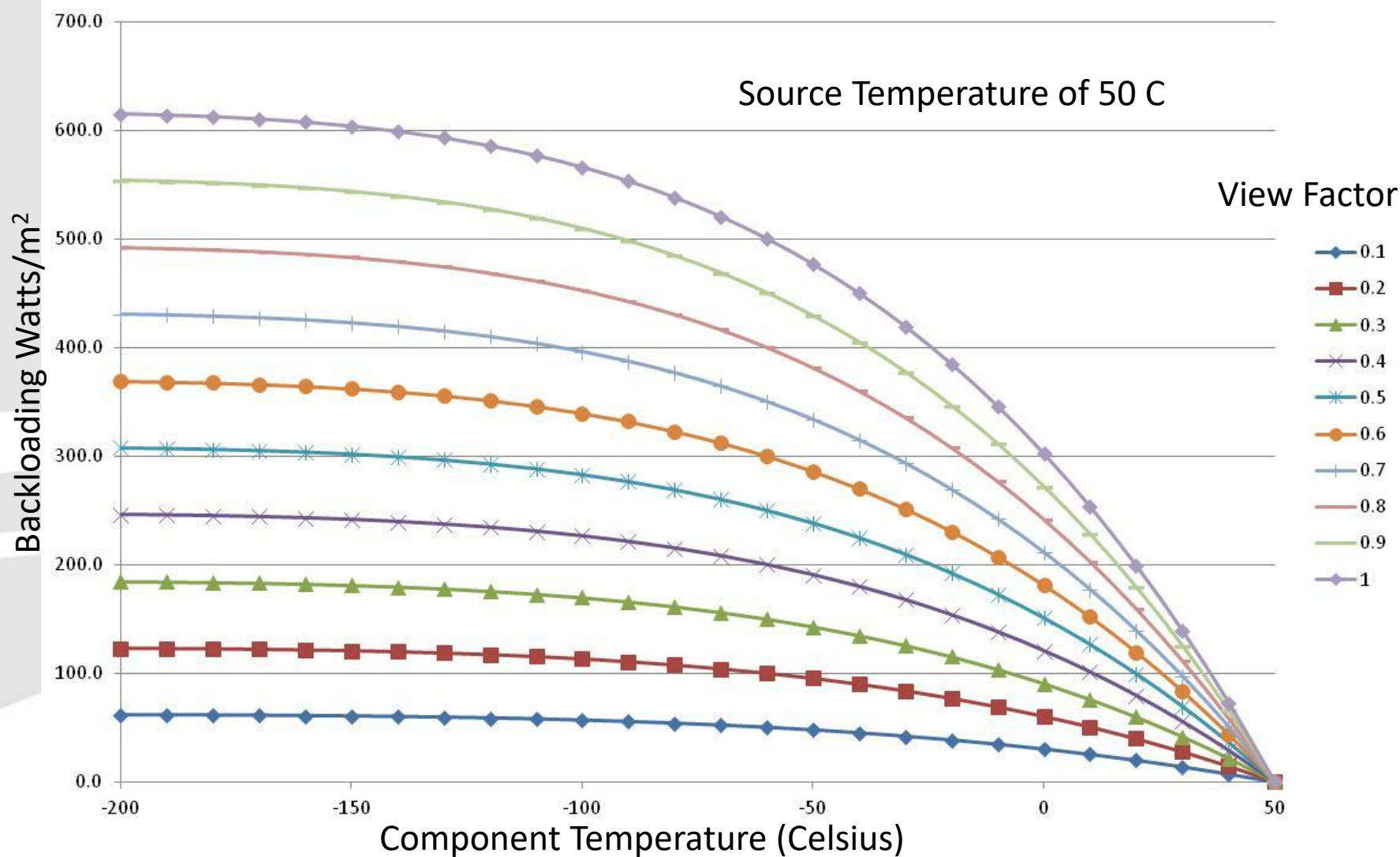
$\sigma$  - Stefan Boltzman Constant



***Homework problem 3 demonstrates how to do hand calculations for backloading***

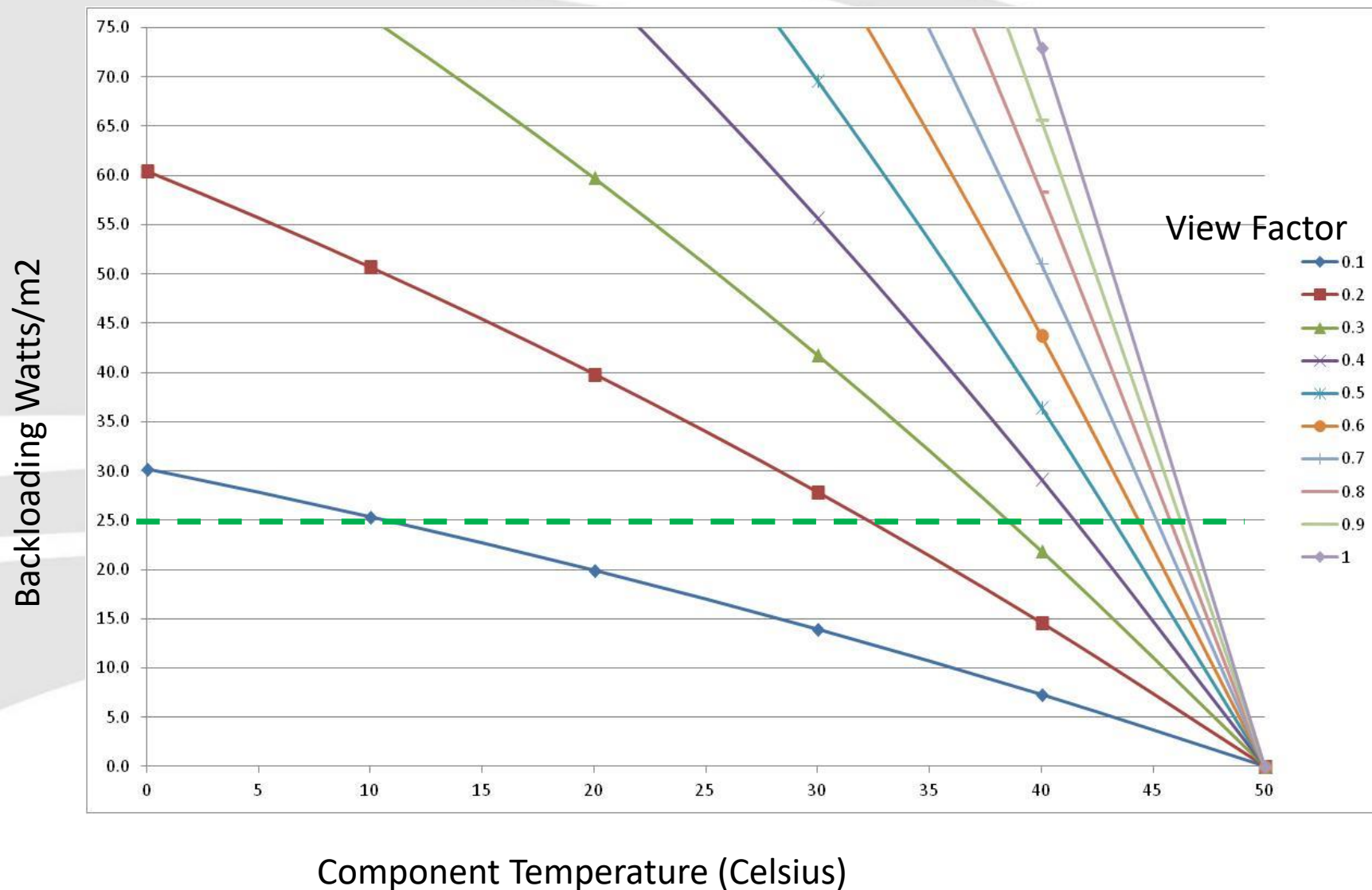


# Backloading from a 50 C Source





## Backloading from a 50 C Source





# Thermal Guidelines



ID	Function	Guidelines	Rationale/Comment
2.9.2 (LEO) 3.9.2(GEO)	Thermal Interface	The instruments should be thermally isolated form the Host Spacecraft	Causes minimal disturbance to spacecraft; makes it easier for the spacecraft to host HPL
2.9.3 (LEO) 3.9.3 (GEO)	Thermal Design at the Mechanic al I/F	The Instrument thermal design should be decoupled from the Spacecraft at the mechanical interface and neighboring payloads as much as possible.	As a hosted payload, the instrument should not interfere with the host spacecraft's functions.





# Thermal Guidelines



ID	Function	Guidelines	Rationale/Comment
2.9.4 (LEO) 3.9.4 (GEO)	Conductive Heat Transfer	The conductive heat transfer at the Instrument-Host Spacecraft mechanical interface should be less than 15 W/m <sup>2</sup> or 4 W.	A conductive heat transfer of 15 W/m <sup>2</sup> or 4 W is considered small enough to meet the intent of being thermally isolated.
2.9.5 (LEO) 3.9.5 (GEO)	Radiative Heat Transfer from the instrument	The TICD will document the allowable radiative heat transfer from the Instrument to the Host Spacecraft.	S/C details will be known after pairing; TICD can document instrument's radiative isolation from S/C and other payload
	Backloading from S/C	Instrument requiring cold radiator should evaluate the effect of backloading from S/C hot parts (solar panels)	Many GEO S/C will have large radiators with view to sides of the S/C



# Thermal Guidelines



ID	Function	Guidelines	Rationale/Comment
2.9.6 (LEO) 5.9.6 (GEO)	Temperature Maintenance Responsibility	The Instrument should maintain its own instrument temperature requirements.	As a thermally isolated payload, the Instrument has to manage its own thermal properties without support from the Host Spacecraft.



# Thermal Guidelines



ID	Function	Guidelines	Rationale/Comment
2.9.7 (LEO) 3.9.7 (GEO)	Instrument Allowable Temperatures	The TICD will document the allowable temperature ranges that the Instrument will maintain in each operational mode/state.	The allowable temperatures drive the requirements for the Instrument and S/C thermal systems



# Thermal Guidelines



ID	Function	Guidelines	Rationale/Comment
2.9.8 (LEO) 3.9.8 (GEO)	Thermal Hardware Responsibility	The Instrument Provider should provide and install all Instrument thermal control hardware including blankets, temperature sensors, louvers, heat pipes, radiators, and coatings.	This function naturally follows the responsibility for the instrument thermal design and maintaining its temperature requirements. The Host Spacecraft will provide only the closeout thermal hardware for the interface such as MLI blanket or the S/C provided heat pipes



# Back Up Charts